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Purpose or Objective: Labour-intensive procedures, such as adaptive radiotherapy and the upcoming new modalities protons and MR linac, result in an increased workload in the treatment planning department. We therefore started the FAST-planning project, a Framework for Automatic Segmentation and Treatment planning. The purpose of this project is to produce single-click automated treatment planning for the majority of tumour sites.

Material and Methods: Easy configuration of treatment protocols was achieved by isolating medical planning protocol relations from software: in-house developed XPP document format (eXtensible Planning Protocol) allows for a complete planning protocol definition in a single document (XML). In FAST planning, the patient ID, dicom identifiers and the selected planning protocol are combined, and an Autoplan document (XML) is composed.
In the framework, each module accepts Autoplan documents and coordinates actions accordingly; e.g. automatic localization of the patient record, import of DICOM objects with delineated target volumes, auto-segmentation of OARs, creation of additional ROIs, creation of advanced beam-setups (VMAT, IMRT), optimization and finally the creation of a report (optionally uploaded to R&V MOSAIQ). The software is written in Python and makes use of Pinnacle3 scripting and transfer protocols DICOM and XML over HTTP. Schemas are used for validation of all XML documents.

Results: The following workflow is automated: after the physician delineated the target, a single mouse-click initiates RT plan generation on our remote treatment planning system Pinnacle3. Subsequently a preview report of the generated plan is send to R&V system MOSAIQ (Fig. 1). The created RT plan is fully optimized and ready for inspection by the dosimetrist. FAST-planning has been implemented into our clinic for Breast, Prostate, and Vertebral metastases.
Nine Prostate protocols (VMAT) are in place for a variety of dose-levels (51, 64.6 and 77Gy) and target definitions (boost/no-boost and inclusion of seminal vesicles). For Breast, 8 IMRT plans (variation in beam-setup and OAR margins) are created; the dosimetrist and physician can select the best plan based on target coverage and dosimetric trade-offs. For vertebral metastases, 2 plans (conformal beam-setups PA and APPA) are created and screenshots in PDF are sent to R&V MOSAIQ for plan evaluation and selection by the physician.

Conclusion: We have introduced fully automated RT planning for treatment plans Breast (in 20min), Prostate (in 20min) and palliative Vertebrae (in 7min). The automation of these treatment sites has reduced the dosimetrist's planning time considerably (up to 2 hours per RT plan), while maintaining the same plan quality. The FAST framework is generic and allows for easy RT planning protocol configuration for the EBRT techniques VMAT, IMRT and conformal fields. The workflow automation currently covers approx. 20% of our patient throughput, i.e. 1250 RT planning sessions/year.

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A novel method for electron beam geometry optimisation

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Purpose or Objective: A normal beam incidence optimizes dose distribution in electron radiotherapy. Historically, electron beam direction is chosen clinically with aid of Computed Tomography (CT) data, but commonly without couch rotation. This work describes a novel method for optimizing electron beam incident angle by varying both gantry and couch angles.

Material and Methods: The treated skin surface could be represented using triangle mesh modeling, the vertices being chosen as points on the treated body contour, and their 3D coordinates obtained from the CT dataset. The optimal beam direction would be parallel to the vector sum of all normal vectors to the defined triangles. For each triangle, the normal vector can be obtained by the cross product of two vectors formed by the triangle vertices.Gantry and couch rotation angles of the electron field could then be derived from the vector sum using simple trigonometric formulation. A computer code based on these formulas was developed. The inputs required are the vertices 3D coordinates, the output being the calculated gantry and couch rotation angles. Ideally, using a larger number of vertices, and consequently a larger number of triangles, increases the similarity between the mesh representation and the real skin surface.For practical reasons, two software versions were generated: one using four vertices selected on the treatment planning system such that they are located on the periphery of the treated skin, and the other using nine points selected on the periphery and evenly distributed within the treated skin. Results were compared for fifteen treatment plans and evaluated clinically in the treatment room and dosimetrically using the Eclipse Monte-Carlo electron algorithm.

Results: The two software versions yielded similar results, the root-mean-square deviation being 1.28° for couch rotation angles and 1.9° for gantry angles. When assessed clinically on patients, the derived beam direction appeared fairly normal to the treated skin surface for all cases. A better dose distribution was obtained using the software particularly for cases with large calculated couch rotation angles.

Conclusion: This software tool is an alternative to the historically used method, is more objective and accurate, may provide a better dose distribution, and is reasonably practical using the four vertices based calculation.

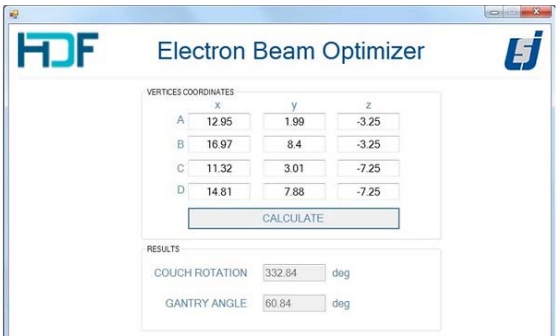

Figure 1A

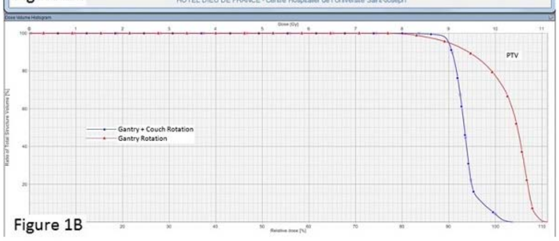

Figure 1B